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CONSTRUCTION OF A SIMPLE AIR FLOWMETER

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In laboratory or field investigations there is often need for a flowmeter with a known delivery rate. A series of durable meters has been designed and constructed by the use of simplified flow equations that govern gases or liquids flowing in a straight line and passing through any constriction in the line of flow. The pressure drop across the constriction is dependent on the rate of flow. The flowmeter described herein may be constructed of parts available from any hardware or plumbing-supply store.

The following equation was found suitable in measuring flow of air with orifice meters:

$$Q = 611\, D_o^2 \sqrt{R}$$

where Q = air flow rate in cubic centimeters per second
D_o = orifice diameter in centimeters
R = manometer reading in centimeters of water

The constant 611 is a simplified value for meters of the type described, derived from more complex, precise equations by the use of certain simplifying assumptions.

With this equation orifice meters may be constructed with a wide range of flow rates.

For purposes of illustration, suppose a flowmeter is to be constructed that will deliver 10 liters of air per minute with a water-manometer differential reading of 10 centimeters.

Q = 10 liters per minute, or 166.7 centimeters per second
R = 10 cm. of water

Substituting in this equation,

$$166.7 = 611\, D_o^2 \sqrt{10}, \quad D_o^2 = \frac{166.7}{611 \sqrt{10}} = 0.0863$$

$$D_o = \sqrt{0.0863} = 0.294 \text{ cm., or } 0.116 \text{ in.}$$

Any unknown conditions may be calculated from the following equation if the flow rate corresponding to any given reading is known:

$$\frac{Q_1}{Q_2} = \sqrt{\frac{R_1}{R_2}}$$

The calculated and calibrated values for four flowmeters of this type are shown below:

D_o, inch	Calculated		Calibrated	
	Q, liters per minute	R, centimeters	Q, liters per minute	R, centimeters
0.313	74 -23.3	10-1	79 -24.1	10-1
.209	33.5-10.6	10-1	39 -12.3	10-1
.164	20 -10	10-2.5	21 -10.6	10-2.5
.116	10 - 3.16	10-1	8.3- 3.5	10-1

The type of meter shown in figure 1 is designed to measure the flow of air at 765 mm. of mercury and 75° F. (23.9° C.). It is constructed from two 1-inch IPT pipe flanges (A and A'), two 1-inch standard pipe nipples 6 inches in length (D and D'), and a 3 1/2-inch brass disk (I) made from 1/32-inch brass sheet. The pipe flanges are attached to the nipples, and to insure a tight unit the threads are sealed with pipe-sealing compound or solder. A hole of the size calculated for the orifice is drilled in the center of the disk I. The drilling may be done on an ordinary drill press with new bits. Four additional holes are then drilled near the circumference of the disk to match the holes of the two pipe flanges.

Two 21/64-inch holes (E and E') are drilled in the 6-inch pipe nipples 15/16 inch from the edge of the flange nearest to the disk and tapped with 1/8-inch IPT. The refrigeration-flared unions (F and F') 1/8-inch IPT x 1/4-inch SAE are used as outlets to the manometer (P_1 and P_2). The threads are made airtight with sealing compound. One-fourth-inch OD-copper tubing (H, H') is connected to the 1/4-inch SAE flared nuts, (G and G'). This copper tubing is connected to the manometer by means of rubber tubing.

Two gaskets (C and C') are cut from standard fiber gasket stock, 1/32 to 1/16 inch, with holes to match the inside of the pipe and the holes in the pipe flange. The unit is assembled with 1-inch flat-head stove bolts (B).

The orifice meter can be calibrated with a standardized wet-test meter or a precalibrated gas meter. The precalibrated gas meter may be obtained from your local gas company. Both types of meters are satisfactory, but for air flows above 10 liters per minute the gas meter has less air resistance. Water displacement, dilution methods, or other accepted types of calibration also may be used.

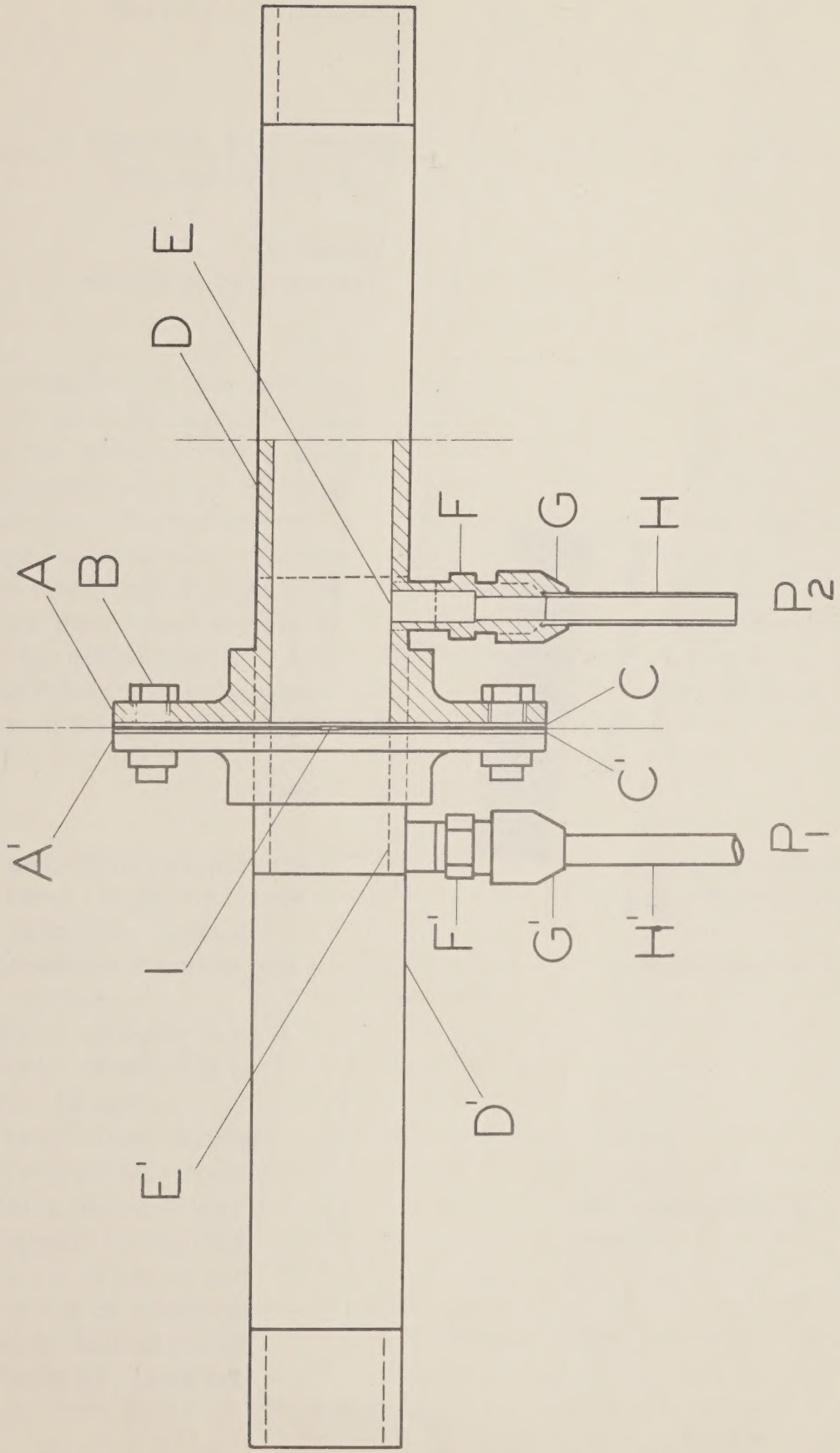

Figure 1.--Construction of a simple air flowmeter. See text for explanation of letters.